U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

Scientific Name:

Chamaecrista lineata keyensis

Common Name:

Big Pine Partridge pea

Lead region:

Region 4 (Southeast Region)

Information current as of:

03/26/2013

Status/Action

___ Funding provided for a proposed rule. Assessment not updated.

___ Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

___ New Candidate

_X_ Continuing Candidate

___ Candidate Removal

> ___ Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status
>
> ___ Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species
>
> ___ Range is no longer a U.S. territory
>
> ___ Insufficient information exists on biological vulnerability and threats to support listing
>
> ___ Taxon mistakenly included in past notice of review
>
> ___ Taxon does not meet the definition of "species"
>
> ___ Taxon believed to be extinct
>
> ___ Conservation efforts have removed or reduced threats

___ More abundant than believed, diminished threats, or threats eliminated.

Petition Information

___ Non-Petitioned

_X_ Petitioned - Date petition received: 05/11/2004

90-Day Positive:05/11/2005

12 Month Positive:05/11/2005

Did the Petition request a reclassification? **No**

For Petitioned Candidate species:

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing? **Yes**

Explanation of why precluded:

Higher priority listing actions, including court-approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for this species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The Progress on Revising the Lists section of the current CNORs(http://endangered.fws.gov/) provides information on listing actions taken during the last 12 months.

Historical States/Territories/Countries of Occurrence:

- **States/US Territories**: Florida
- **US Counties**: Monroe, FL
- **Countries**:Country information not available

Current States/Counties/Territories/Countries of Occurrence:

- **States/US Territories**: Florida
- **US Counties**: Monroe, FL
- **Countries**:Country information not available

Land Ownership:

Big Pine partridge pea occurs on two islands, Big Pine Key and Cudjoe Key. Almost the entire population occurs on Big Pine Key where it is distributed across most of the island (Bradley 2006, p. 15). The majority of the population is on the National Key Deer Refuge (NKDR) over an area of about 800 acres (323.7 hectares [ha]). Some plants are on The Nature Conservancys (TNC) 3.2 acres (8 ha) Terrestris Preserve. Plants also occur on conservation lands owned by the State of Florida, road right-of-ways owned by the Florida Department of Transportation and Monroe County, and properties owned by Monroe County. Some plants also occur on private lands. Plants on Cudjoe Key are all in road right-of-ways with NKDR adjacent

(Hodges and Bradley 2005, p. 21). Over 80 percent of the population probably exists on Federal lands, with the rest distributed amongst State, County, and private owners.

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Biological Information

Species Description:

A small prostrate to ascending herbaceous shrub with yellow flowers and pinnately-compound leaves. Young branches are pilosulous; stipules 3-9.5 x 0.7-2 mm.[millimeters]; leaves 1.7-3.5 (-4) cm [centimeters]; gland 0.3-0.6 mm diameter, sessile or nearly so; leaflets (5-) 6-9 pairs, oblong-lanceolate, obtuse mucronulate, 7-12 x 2-4.5 (-5) mm; sepals 9-20 mm long; petals 11-15 mm long; ovules 10-13; pod 33-45 x 4.5 5 mm, pilosulous. (Bradley and Gann 1999, p. 17; adapted from Irwin and Barneby 1982, p. 757).

Taxonomy:

This subfamily is mostly tropical, including nickers (Caesalpinia). The genus Chamaecrista includes about 265 species distributed throughout the world (Irwin and Barneby 1982, p. 636), including several common annual and perennial plants of the southeastern U.S., especially *Chamaecrista fasciculata*, the partridge pea, which occurs throughout Florida. The authoritative taxonomic treatment of Chamaecrista and its relatives is by Irwin and Barneby (1982, pp. 1-918). *Chamaecrista lineata var. lineata* is almost ubiquitous in the Bahama Archipelago, including the Turks and Caicos, and is present in Cuba and Hispaniola (Correll and Correll 1982, p. 621). *Chamaecrista lineata var. brachyloba* is present in Cuba, Hispaniola, and Puerto Rico (Liogier 1988, p. 71).

John Loomis Blodgett was the first to collect Big Pine partridge pea, sometime between 1838 and 1852 on Big Pine Key. Pollard (1894, p. 217) recognized that Blodgetts specimen was different than other Florida species of Chamaecrista, calling it *C. grammica*, a name now applied to the West Indian *C. lineata var. brachyloba* (Irwin and Barneby 1982, p. 757). Small (1903, p. 587; 1913, p. 58) followed this usage. In 1917 Pennell (p. 344) recognized it as a distinct endemic species, naming it *Chamaecrista keyensis*. This name was also retained by Small (1933, p. 663). In 1919, Macbride placed the taxon in the genus Cassia, creating the name *Cassia keyensis* (Macbride 1919, p. 24). Isely (1975, p. 104) and Long and Lakela (1971, p. 457) followed this treatment. In an exhaustive study of Cassia and Chamaecrista in 1982 (p. 757), Irwin and Barneby noticed the similarity between plants in Florida and other parts of the West Indies. Retaining the Keys plant in the genus Chamaecrista, Irwin and Barneby (1982, p. 757) named the plant *C. lineata var. keyensis*, retaining it as endemic with close relatives (varieties lineata and brachyloba) in the Bahamas and Cuba. Isely (1990, p. 33), Wunderlin (1998, p. 348), and Wunderlin and Hansen (2003, p. 441) have followed this treatment. Synonyms of *C. lineata var. keyensis* are: *Cassia keyensis* (Pennell) J.F. Macbr.; *Chamaecrista keyensis Pennell*; *Chamaecrista grammica Spreng*., misapplied; and, *Cassia grammica Spreng* ., misapplied (Bradley and Gann 1999, p. 17).

The Integrated Taxonomic Information System (2011, p. 1) uses the name *Chamaecrista lineata var. keyensis* and indicates that this species taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) and NatureServe (2010, p. 1) also use the name *Chamaecrista lineata var. keyensis*. In summary, there is consensus that *Chamaecrista lineata var. keyensis* is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon.

Habitat/Life History:

Big Pine partridge pea occurs primarily in pine rockland vegetation. Some populations can be found on roadsides (Hodges and Bradley 2005, p. 22) or in cleared lots adjacent to pine rockland. Pine rocklands in the lower Florida Keys are dominated by a canopy of *Pinus elliottii var. densa* (South Florida slash pine). The subcanopy is composed of *Thrinax morrisii* (brittle thatch palm), *Psidium longipes* (longstalked stopper), *Metopium toxiferum* (poisonwood), *Byrsonima lucida* (locustberry), *Pithecellobium keyense* (blackbead), and *Coccothrinax argentata* (silver palm) (Bradley 2006, p. 25). Bradley (2006, p. 31) found 30 taxa with statistically significant associations with Big Pine partridge pea on Big Pine Key. Taxa with the highest indicator values, in descending order, included *Rhynchospora floridensis* (Florida whitetop), *Schizachyrium gracile* (wire bluestem), *Anemia adiantifolia* (maidenhair pineland fern), *Psidium longipes* (long-stalked stopper), *Sorghastrum secundum* (lopsided indiangrass), and silver palm. Ross and Ruiz (1996, p. 5) found that it occurs primarily in areas where hardwoods are relatively unimportant, and where understory and overstory palms are important. Bradley (2006, p. 26) also found that it preferred open sunny areas, but in contrast to Ross and Ruiz (1996, p. 5) found a negative correlation with palm cover. Big Pine partridge pea is most likely to be found in canopy openings and requires full sun to partial shade (Muir and Liu 2003, p. 3). It is capable of colonizing disturbed areas within pine rockland habitat, such as dirt roads. It does not persist in damp soil or depressions (Muir and Liu 2003, p. 3).

Pine rockland is maintained by relatively frequent fires, which keep the understory woody plants at shrub height (Snyder *et al.* 1990, pp. 257-263; Carlson *et al*. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; 2005b, p. 71). In the absence of fire, many areas become wooded, eventually succeeding to rockland hammock (i.e., hardwood forest) (Snyder *et al*. 1990, p. 260). As with other pineland plants, Big Pine partridge pea is shade intolerant, and requires periodic burning to reduce competition from woody vegetation (e.g., shading, leaf litter accumulation) (Carlson *et al*. 1993, p. 922; Liu *et al*. 2005a, p. 210; 2005b, p. 71). Bradley and Saha (2009, p. 28) observed a strong negative relationship between time since fire and Big Pine partridge pea density, illustrating negative impacts where fire is suppressed. Fire frequency, a related variable, also had a significant impact, with Big Pine partridge pea density greatest in plots that had burned 3-4 times between 1960 and 2005, as opposed to plots with fewer or no burns (Bradley and Saha 2009, p. 29). Similarly, graminoid (i.e., true grasses, sedges and rushes) cover was significantly higher in plots with higher fire frequencies and shorter times since fire. In contrast, hardwood cover was lower in frequently burned plots (Bradley and Saha 2009, p. 29).

Alexander and Dickson (1972, p. 93) suggested that the succession process to hardwood forest may take up to 50 years in the Keys. A fundamental question about fire ecology in pine rocklands is how frequently they should burn and during what season. Snyder *et al*. (1990, pp. 261-262) inferred the historic fire regimes on the Florida mainland by looking at the time it takes for the herbaceous layer to be excluded from an area by shading (maximum time between fire) and the point where enough fuel is available to carry a fire (minimum time since fires). The minimum fire regime found was 2-3 years and the maximum was 15 years (Snyder *et al* . 1990, pp. 261-262). This wide range in fire frequencies would result in different forest structures and dynamics. Due to low precipitation and poor soils, the vegetation in the Keys does not grow as rapidly as it does on the mainland. Carlson *et al*. (1993, p. 926) suggested that a burn frequency of 5-10 years would have the greatest benefit to lower Keys pine rockland and Key deer (Odocoileus virginianus clavium). Liu *et al*. (2005a, p. 218) found that extinction probabilities of Big Pine partridge pea were lowest if burns were conducted every 5-8 years.

Fires influence Big Pine partridge pea population sizes which vary annually depending upon fire behavior and seasonality. Liu (2003, p. 53) found that fires kill up to 80 percent of the plants, with higher mortality during summer burns than winter burns. Liu (2003, p. 43) found that Big Pine partridge pea populations recover faster after winter or early summer (May to June) burns than after late-summer, wet season (July to

September) burns. Reproduction (seed production) was greater after more intense fires, but fire intensity does not appear to affect survival, growth, or seedling establishment (Liu 2003, pp. 47-48). In demographic modeling Liu et al. (2005a, p. 219) found that wet and dry season fires changed the extinction probability of this taxon. Burns conducted only in the summer had the highest extinction probability. Burns conducted only in the winter resulted in low probability of population decline. Liu (2003, p. 139) suggested that a fire frequency of 7 years would create the lowest extinction probability for Big Pine partridge pea, and that a fire regime with a wide range of burning seasons may be essential for this and other endemic species of the lower Keys. The authors suggested that burns be conducted in early summer and winter to ensure the health and continued existence of C. keyensis (Liu *et al*. 2005a, p. 219). Populations declined in areas that have not burned for more than 10 years (Liu 2003, p. 137).

Several life history attributes of Big Pine partridge pea have been the subject of study by Hong Liu, whose doctoral dissertation focused on this plant (Liu 2003 pp. 1-190; Liu and Koptur 2003, pp. 1180-1187; Liu *et al*. 2005a, pp. 210-221; Liu *et al*. 2005b, pp. 71-76). Lius research focused on fire ecology and demography (discussed above), breeding systems, and pollination. Big pine partridge pea was found to have a peak flowering period from May through August, with each flower opening for a single day (Liu 2003, p. 7). While the species is self compatible, it requires certain insects for successful pollination (Liu 2003, p. 14; Liu and Koptur 2003, p. 1184). Because of poricidal dehiscence (pollen is released through pores) of the anthers, pollen cannot move on its own from the anthers to the stigma (Liu 2003, p. 14; Liu and Koptur 2003, p. 1184). Buzz pollinators, insects with forceful wing movements that can shake pollen free of the anthers, are required for seed set (Liu 2003, p. 13; Liu and Koptur 2003, p. 1184). Bees in seven genera were found to visit the flowers, but only two genera carried out buzz pollination and were thought to act as pollinators (Liu 2003, p. 13; Liu and Koptur 2003, p. 1183). These pollinators were most active between 9:00 and 10:00 A.M. (Liu 2003, p. 10; Liu and Koptur 2003, p. 1184). Liu (2003, p. 15) and Liu and Koptur (2003, p. 1183) also found that seed production was lower in urban areas due to seed loss to an unidentified seed predator.

Historical Range/Distribution:

The historical range of Big Pine partridge pea included Big Pine Key, Cudjoe Key, No Name Key, Ramrod Key, Little Pine Key, and perhaps Sugarloaf Key, all in the lower Keys, Monroe County (Hodges and Bradley 2005, pp. 20-24). It has not been documented on No Name Key since 1895 and Ramrod Key since 1911 (Bradley and Gann 1999, p. 17). Although it has not been vouchered on No Name Key since 1895, it persisted there until at least the late 1900s. Folk (1991, pp. 203, 639), listed it as the seventh most important pine rockland herb on the island with a cover of 0.32 percent and 10 percent frequency. Folk (1991, pp. 203, 651) also listed the taxon for Little Pine Key, where it had not been previously reported, listing it as the ninth most important pine rockland herb on the island with a cover of 0.08 percent and a 7 percent frequency.

Big Pine partridge pea is also reported from Miami-Dade County (Wunderlin and Hansen 2003, p. 441), but The Institute for Regional Conservation (IRC) (2011, p. 1) considers this report to be in error. The report is based on a herbarium specimen at the University of South Florida herbarium collected by Robert Long and H. Andorfer on April 12, 1969, at Brickell Hammock: Vicinity of US 1 and Rickenbacker Causeway. This is Longs specimen #2824. It is an unlikely location for the species for two reasons. The first is that the site is a rockland hammock, poor habitat for the species. At the time of Longs visit all pine rockland habitat in the area had been destroyed. The second reason is that by the time of Longs visit, Brickell Hammock had been visited by almost every botanist to ever visit Miami, so the chances of him locating a new species were small. This seems to be a case of a mislabeled specimen. In addition, his #2823 of Matelea floridana also labeled as being collected at Brickell Hammock is equally unlikely, since it is otherwise unknown south of Manatee County. It is probable that these specimens were collected elsewhere and incorrectly attributed to Brickell Hammock.

Current Range Distribution:

Big Pine partridge pea is widespread only on Big Pine Key. There, it is distributed throughout the range of pine rockland, though more widespread in the northern than southern portion of the key (Bradley 2006, p. 15; Bradley and Saha 2009, p. 2). While most known plants occur on NKDR, it also occurs on TNCs Terrestris Preserve, State- and County-owned conservation lands, road right-of-ways, and private lots. It is most common in pine rocklands, and on Big Pine Key, pine rocklands encompass approximately 1,438 acres (582 ha), according to calculations derived from the Advanced Identification of Wetlands in the Florida Keys project data (MacAulay et al. 1994, GIS data only).

Bradley and Saha (2009, pp. 1-8) conducted systematic surveys of publicly-owned pine rockland (1,181 acres

[478 ha]) throughout Big Pine Key to determine the population size and distribution of Big Pine partridge pea during two periods, 2005-2006 and 2007-2008 (hereafter 2005 and 2007, respectively, unless noted otherwise). In 2005, during the early part of the study, a tidal surge generated by Hurricane Wilma flooded much of Big Pine Key (Bradley and Saha 2009, p. 2). Bradley (2006, p. 13) found it in 200 of 332 (60.2 percent) pine rockland sample plots in 2005, prior to Hurricane Wilma. Frequency of occurrence declined significantly between 2005 and 2007. In those plots that were initially sampled before Hurricane Wilma, frequency of occurrence declined 56 percent (48 and 21 percent of plots were occupied by Big Pine partridge pea in 2005 and 2007, respectively) (Bradley and Saha 2009, p. 12). In both 2005 and 2007, the frequency of occurrence in plots was significantly higher in northern than the southern pine rocklands (Bradley and Saha 2009, p. 9). Big Pine partridge pea was recorded in 62 and 26 percent of all plots in northern pine rocklands, respectively, in 2005 and 2007. Frequency of occurrence in southern pine rocklands was 36 and 2 percent in 2005 and 2007, respectively (Bradley and Saha 2009, p. 9). Ross and Ruiz (1996) found it in 130 of 145 (89 percent) pine rockland sample plots.

In 2005, approximately 150 plants were found in pine rockland on Cudjoe Key (Hodges and Bradley 2005, p. 21); this subpopulation covered about 0.5 acres (0.2 ha). During the summer of 2005, a subpopulation was also discovered along a county road on Lower Sugarloaf Key consisting of only a few plants (Hodges and Bradley 2005, p. 22). This may represent a recent range expansion, since there is no additional suitable habitat for the species in the vicinity of this subpopulation (Hodges and Bradley 2005, p. 22). This subpopulation could not be located after Hurricane Wilma, and the plants were probably killed by the tidal surge (Hodges and Bradley 2005, p. 22). In 2007 and 2008, Bradley and Saha (2009, p. 4) expanded the area of systematic surveys to include publicly owned pine rockland throughout Cudjoe Key (178 acres [72 ha]), Little Pine Key (131 acres [53 ha]), No Name Key (138 acres [56 ha]), and Sugarloaf Key (94 acres [38 ha]). Big Pine partridge pea was not found in these study plots. However, Big Pine partridge pea was observed again at the roadside site on Cudjoe Key (Bradley and Saha 2009, p. 11).

Big Pine partridge pea has also been reported to be present at the U.S. Department of Agriculture Subtropical Horticultural Research Station at Chapman Field in Miami-Dade County (Kabat et al. 2006, p. 369). Pine rockland habitat at the station has been surveyed for rare plant species numerous times without revealing Big Pine partridge pea (K. Bradley, IRC, pers. comm. 2007). Because there are no other reliable reports of this species from Miami-Dade County, and because the report is approximately 150 kilometer (km) (93 miles) from Big Pine Key, this report is most likely an error, based on a misidentification of another Chamaecrista species. Attempts to check the identity of the specimen have been unsuccessful (K. Perkins, University of Florida Herbarium, pers. comm. 2007). The specimen should be examined to verify its identification.

Population Estimates/Status:

Total population size within the Big Pine Key public pine rockland study area (1,181 acres [478 ha]) was estimated to be 816,833 to 1,709,994 in 2005 (pre-Hurricane Wilma, 297 plots) and 178,543 to 458,227 in 2007 (post-Wilma, 285 plots) (Bradley and Saha 2009, p. 12). Since 82 percent of the pine rockland on Big Pine Key is publicly owned, this estimate likely accounts for the majority of the population. Big Pine partridge pea density and percent cover was significantly higher in 2005 compared to 2007 in all plots combined, as well as, separately for northern and southern plots. In 2005, a total of 1,540 plants were counted in 297 plots, whereas in 2007 only 584 plants were counted in 285 plots. Mean density was 5.18 plants per plot in 2005 and 2.04 plants per plot in 2007 (Bradley and Saha 2009, p. 9). In both 2005 and 2007, the density was significantly higher in northern (5.31 and 2.87 plants per plot, pre- and post-Wilma, respectively) than the southern (2.35 and 0.86 plants per plot, pre- and post-Wilma, respectively) pine rocklands (Bradley and Saha 2009, p. 9). In surveys collected immediately after Hurricane Wilma, island-wide population sizes were 38 percent lower than in plots sampled prior to the hurricane (Bradley 2006, p. 35). Mortality rates varied geographically. Small areas of pine rockland were not flooded at all, while in many areas salt water pooled for several days. Bradley (2006, p. 13) sampled 60 plots both before and after the hurricane. These plots were all at the northeast end of the island in a low-lying area. Only 6.25 percent of the plants that were found prior to the hurricane were found after the storm, indicating a major population decline. Similarly, at

TNCs Terrestris Preserve, counts of Big Pine partridge pea declined greatly between 2003 and 2006 in all three study units (Slapcinsky and Gordon 2007, p. 9).

The subpopulation on Cudjoe Key was approximately 150 plants in 2005 (Hodges and Bradley 2005, p. 21). Bradley and Saha (2009, p. 11) determined that Big Pine partridge pea persisted on Cudjoe Key as of 2008, but that road-side population was not enumerated in that study.

The population size of Big Pine partridge pea is apparently much smaller than it was historically. In addition to a reduction in the amount of available habitat (see Factor A below), there has also been a reduction in density. Bradley (2006, p. 35) extrapolated densities from data collected in 1951 from Dickson (1955) and from data collected in 1969-1970 (Alexander and Dickson 1972). Extrapolations from the 1951 and 1969 data suggested densities of 4,335 plants/acre (10,764 plants/ha) and 11,279 plants/acre (27,871 plants/ha), respectively. These values are substantially higher than the 2005, pre-Wilma estimate of 1,018 plants/acre (2,516 plants/ha) (Bradley 2006, p. 35). These density differences may be in part due to artifacts of different sampling schemes, but likely reflect an actual reduction in densities across the island.

The species was not found during a two-year project intended to survey and map exotic and rare plants along Florida Department of Transportation (FDOT) right-of-ways within Monroe (and Miami-Dade) County (Gordon *et al*. 2007, pp. 1, 36).

FNAI (2011, pp. 2, 28) considers the FNAI State element rank of Big Pine partridge pea to be S2, imperiled in Florida because of rarity (6 to 20 occurrences or less than 3,000 individuals) or because of vulnerability to extinction due to some natural or man-made factor. NatureServe (2010, p. 1) considers its rounded global status as T2, imperiled. It is listed as endangered by the State.

Threats

A. The present or threatened destruction, modification, or curtailment of its habitat or range:

Nearly one half of the Big Pine partridge pea habitat on Big Pine Key has been lost to development. The acreage of pine rockland on the island was reduced from 2,592 acres (1,049 ha) in 1955 to 1,732 acres (701 ha) by 1989 (Folk 1991, p. 188) and to 1,438 acres (585 ha) in 1994 (MacAulay *et al*. 1994, GIS data only). This trend of habitat development, while a major historical factor, is now greatly reduced. Change in percent human population for Monroe County from April 1, 2000 to July 1, 2009 was -8.1 percent (http://quickfacts.census.gov). Most pine rockland habitat on Big Pine and Cudjoe Keys is owned by conservation agencies.

A Habitat Conservation Plan (HCP) for the Key deer and other listed species limits development mainly to previously cleared lands on Big Pine and No Name Keys (Monroe County *et al*. 2006, p. 4). Under this HCP, no more than 168 acres (68 ha) can be developed over the next 3 years, and of this no more than 7 acres (2.8 ha) will be native habitat. Although the HCP focuses on the Key deer, Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), and eastern indigo snake (*Drymarchon corais couperi*), the plan is expected to benefit Big Pine partridge pea by limiting development in pine rockland habitat within the majority of its current range on Big Pine Key. However, since plants also can be found on roadsides (Hodges and Bradley 2005, p. 22) and in cleared lots adjacent to pine rockland, there is potential for additional loss from development and road construction on Big Pine Key. While roadsides may provide some temporary habitat, these areas are not good long-term habitat due to the absence of fire, use of herbicides, and encroachment of exotics. In short, despite the HCP, both good quality habitat and more marginal roadside habitat are expected to be lost on Big Pine Key. Other portions of the species current (i.e., Cudjoe Key) and historic range are not part of the HCP.

Climatic changes, including sea level rise, are major threats to south Florida, including this species and its habitat. The Intergovernmental Panel on Climate Change (IPCC) reported that the warming of the worlds climate system is unequivocal based on documented increases in global average air and ocean temperatures, unprecedented melting of snow and ice, and rising average sea level (IPCC 2007, p. 2; 2008, p. 15). Sea-level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the sub-tropical ecoregion of southern Florida (U.S. Climate Change Science Program [CCSP] 2008, pp. 5-31, 5-32). The long-term record at Key West shows that sea level rose on average 0.088 inches (0.224 cm) annually between 1913 and 2006 (National Oceanographic and Atmospheric Administration [NOAA] 2008, p. 1). This equates to approximately 8.76 inches (22.3 cm) over the last 100 years (NOAA 2008, p. 1).

IPCC (2008, p. 28) emphasized it is very likely that the average rate of sea-level rise during the 21st century will exceed that from 1961 to 2003 (i.e., 0.071 inches [0.18 cm] per year), although it was projected to have substantial geographical variability. Partial loss of the Greenland and, or Antarctic ice sheets could result in many feet (several meters) of sea-level rise, major changes in coastlines, and inundation of low-lying areas (IPCC 2008, pp. 28-29). Low-lying islands and river deltas will incur the largest impacts (IPCC 2008, pp. 28-29). Because dynamic ice flow processes in ice sheets are poorly understood, timeframes are not known; however, modeling indicates that more rapid sea-level rise on century timescales cannot be excluded (IPCC 2008, p. 29). According to CCSP (2008, p. 5-31), much of low-lying, coastal south Florida will be underwater or inundated with salt water in the coming century.

IPCC (2008, pp. 3, 103) concluded that climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises and that sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas. From the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams *et al*. 1999, pp. 2056-2059), expansion of mangroves into adjacent marshes in the Everglades (Ross *et al*. 2000, pp. 9, 12-13), and loss of pine rockland in the Keys (Ross *et al*. 1994, pp. 144, 151-155). Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically grade from salt to brackish to freshwater species. Human developments will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; CCSP 2008, p. 7-6).

In the Keys, not only are elevation differences between such communities very slight (Ross *et al*. 1994, p. 146), but the horizontal distances are small as well. Sea level rise poses a significant threat to the species and its habitat. There has been a 15 cm (5.9 inch [in]) rise in sea level over a 70-year period in the vicinity of Big Pine Key (Ross *et al*. 1994, p. 145). The pine rockland community in the Keys has undergone a reduction due to sea level rise (Ross *et al*. 1994, p. 149). For example, the pine rockland area on Sugarloaf Key covered 217 acres (88 ha) prior to 1935, and was reduced to 114 acres (46 ha) by 1935 and 74 acres (30 ha) by 1991 (Ross *et al*. 1994, p. 149). The loss of pine rockland communities was correlated with elevated ground- and soil-water salinity, and loss of upland plant diversity was inferred (Ross *et al*. 1994, pp. 150-151). In areas affected by sea level rise, communities of halophytic plants replaced pine rockland communities (Ross *et al*. 1994, p. 152). Sea level rise of the same order likely occurred among the nearby Big Pine and Cudjoe Keys, but the effects have yet to be quantified on those keys. Based on IPCC and other predictions of sea level rise, Clough (2008, p. 23) concluded that a significant proportion of upland habitat will be lost on Big Pine Key by 2100.

TNC (2010, p. 1) used high-resolution digital elevation models derived from highly accurate Light Detection and Ranging (LIDAR) remote sensing technology to predict future shorelines and distribution of habitat types for Big Pine Key based on sea level rise predictions ranging from the best-case to worst-case scenarios described in current scientific literature. In the Florida Keys, TNC models predicted that sea level rise will first result in the conversion of habitat, and eventually the complete inundation of habitat. In the best-case scenario, a rise of 7 inches (18 cm) would result in the inundation of 1,840 acres (745 ha) (34 percent) of Big Pine Key and the loss of 11 percent of the islands upland habitat (TNC 2010, p. 1). In the worst-case scenario, a rise of 4.6 feet (140 cm) would result in the inundation of about 5,950 acres (2,409 ha) (96 percent) and the loss of all upland habitat (TNC 2010, p. 1).

Similarly, using a spatially explicit model for the Keys, Ross et al. (2009, p. 473) found that mangrove habitats will expand steadily at the expense of upland and traditional habitats as sea level rises. Most of the upland and transitional habitat in the central portion of Sugarloaf Key is projected to be lost with a 0.7 ft-rise (0.2 m-rise) in sea level; a 1.6 ft-rise (0.5 m-rise) in sea level can result in a 95 percent loss of upland habitat by 2100 (Ross *et al*. 2009, p. 473). Furthermore, Ross *et al*. (2009, pp. 471-478) suggest that interactions between sea-level rise and pulse disturbances (e.g., storm surges or fire [see Factor E]) can cause vegetation to change sooner than projected based on sea level alone.

At present, fire suppression is one of the greatest threats to Big Pine partridge pea. Bergh and Wisby (1996, pp. 1-23) detail the fire history of pine rocklands in the lower Keys. While fires naturally occurred at least once or twice per decade, the fire frequency since about 1950 has been sharply reduced throughout the island, despite occasional prescribed burns conducted by the Service and TNC (Bergh and Wisby 1996, p. 1). While fire suppression has been the most problematic adjacent to developed areas, all pine rockland areas on Big Pine Key have suffered, including pine rockland within the NKDR. Because of this drop in burn frequency, habitat characteristics have changed. For example, Alexander and Dickson (1972, p. 90) indicated that brittle thatch palm densities tripled in the years from 1951 to 1952 and 1969 to 1970. Historical photographs of Big Pine Key show a very open understory (e.g., Figure 1 in Alexander and Dickson 1972, p. 89); however, the understory across much of Big Pine Key now includes dense thatch palms. Bradley (2006, p. 26) found a negative correlation between Big Pine partridge pea and palm cover, indicating that vegetation changes associated with a reduced fire frequency are detrimental to Big Pine partridge pea. Carlson et al. (1993, p. 914) reported similar findings for this and other endemic plants on Big Pine Key. Without periodic fires, hardwoods and palms encroach into pine rockland and create too much shade for Big Pine partridge pea. Without periodic fires Big Pine partridge pea populations have a high likelihood of extinction (Liu 2003, p. 137).

Fire is required to maintain the pine rockland community (Snyder *et al*. 1990, pp. 257-263; Carlson *et al*. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu *et al*. 2005a, p. 210; Liu *et al*. 2005b, p. 71). With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like Big Pine partridge pea. Fire suppression reduces the size of the areas that do burn, and habitat fragmentation prevents fire from moving across the landscape. Accordingly, in the absence of fire, pine rockland communities tend toward becoming tropical hardwood hammock communities. NKDR is attempting to address these problems; however, 50+ years of fire suppression has caused changes in pine rockland community structure that are very difficult to reverse. In 2003, NKDR burned a 120-acre (48.6-ha) site on Big Pine Key that had been unburned for 17 years; this was the largest NKDR burn in recent years. Still, NKDR is behind schedule for prescribed burns. Of 318 pine rockland plots that were initially assessed on Big Pine Key in 2005, 110 were not burned, 77 were burned once, 55 were burned twice, and 76 were burned either three or four times since 1960 (Bradley and Saha 2009, p. 22). If a return interval of approximately 7 years would be most beneficial for Big Pine partridge pea as suggested by Liu (2003, p. 139), then these areas should have burned multiple times since 1960 in order to be more optimal. Among numerous species and species assemblages assessed in the pine rockland study, Bradley and Saha (2009, p. 20) found that: The strongest effects of fire were observed on the density of Chamaecrista lineata with the greatest density observed in plots that were burned three times through 2005. Limited fires, and limited habitat conditions for Big Pine partridge pea, was evident on pine rocklands on other islands including No Name, Sugarloaf and Little Pine keys (Bradley and Saha 2009, p. 28).

Two burns totaling 10 acres (4 ha) were burned on NKDR in 2009 (A. Morkill, pers. comm. 2010). NKDR is assessing rare plant response to the prescribed burns in 2009, including the response by Big Pine partridge pea (Anderson 2010, slide 19). In study plots, 757 plants were found before the burn was implemented; this was reduced to 612 plants 2 months post-fire and 205 plants 4 months post-fire (Anderson 2010, slide 19). It is speculated that this immediate reduction in plant numbers may be due to winter senescence, herbivory, or both (Anderson 2010, slide 19). Additional post-fire monitoring should help clarify reasons for short-term declines and potential differences in long-term responses.

Slapcinsky et al. (2010, pp. 4-10) examined the fire responses of 18 rare plant species from 14 families occurring on sandhill, scrub, pine rockland, and mixed deciduous hardwood communities in Florida to better understand the likely negative impacts of fire suppression. Across all species and life history traits, variables for 9 of the 18 species (50 percent) showed statistically significant positive responses to fire, and variables for 9 species (50 percent) showed neutral responses; no species showed a significantly negative response to fire (Slapcinsky *et al*. 2010, p. 11). None of the species studied were unable to recover post-burn (Slapcinsky *et al*. 2010, p. 4). Big Pine partridge pea showed statistically significant density increases following fire during the period monitored (8 years) (Slapcinsky *et al*. 2010, p. 11). Slapcinsky *et al*. (2010, p. 16) suggest that the duration of monitoring might be insufficient to fully clarify patterns of responses to fire. In general, Slapcinsky *et al*. (2010, p. 4) argue that prescribed fire in pyrogenic habitats should not be delayed until species-specific responses to fire are understood.

Complete implementation of a prescribed fire program in the lower Keys has been hampered by an incomplete understanding of the fire ecology in the area, and by public opposition to burning. To address ecological aspects of burning, several research studies have been conducted. For 10 years at the Terrestris Preserve, TNC has been conducting relatively frequent, growing-season prescribed fire, experimental mechanical pre-fire fuel treatments, and ongoing monitoring to quantify the effects of these efforts on community structure and rare plants (Slapcinsky and Gordon 2007, p. 1). The Service is working cooperatively with Florida International University in Miami to determine the proper fire frequencies necessary to maintain the pine rockland community on NKDR (Snyder *et al*. 2005, pp. iv - v). Liu (2003, pp. 1-2) conducted detailed demographic studies of Big Pine partridge pea and how it relates to fire. Carlson *et al* . (1993, pp. 914-918) studied the importance of fire as it relates to Key deer browse, succession, and endemic herbs. Possibly the most relevant fire management issue with respect to Big Pine partridge pea is whether NKDR can conduct some fires in the dry (winter months) or early rainy seasons, a procedure that Liu (2003, p. 139) suggests would benefit this species. Liu (2003, p. 139) indicated that fire frequency intervals of 7 years are optimal, frequencies of less than 7 years may be detrimental, and frequencies of 10 or more years will result in population decline.

Public perception of prescribed burning is widely variable across the United States (Manfredo *et al*. 1990, pp. 20-22). This is no exception in the lower Keys, where many residents are strongly opposed to the use of prescribed fire. This opposition has limited the ability of NKDR to conduct burns as frequently as needed. Complicating the issue is that many homes on Big Pine Key and other islands have been built in a mosaic of pine rockland, so the use of prescribed fire in many places has become complicated because of potential danger to structures.

In summary, Big Pine partridge pea has been impacted by loss of pine rocklands in the lower Keys. Although most remaining habitat is now protected on public lands, the Big Pine partridge pea is threatened by climatic changes, including sea-level rise, which are major, long-term threats that will be difficult to address. Fire suppression and general lack of prescribed fire, which results in the loss and degradation of habitat, is also a significant threat. Overall, the magnitude of threats is moderate.

B. Overutilization for commercial, recreational, scientific, or educational purposes:

None known.

C. Disease or predation:

Liu and Koptur (2003, p. 1183) found that Big Pine partridge pea seed production was lower (fewer seeds per fruit) along urban edges compared to more pristine areas within NKDR. This was attributed to seed predation by insects (an unidentified seed predator), which was found only along the urban interface. Anderson (2010, slide 19) suggested that the reduction of plants post fire at NKDR may have been due to winter senescence, herbivory, or a combination of both.

In addition, Dooley (1975, p. 53) reported that leaves and, or stems are eaten by Key deer. However, this species seems to be eaten very infrequently by Key deer, as this and one other Cassia species were found at a 6 percent frequency in Key deer rumen, at a volume of only 0.02 percent (Dooley 1975, p. 51). Because of these extremely low rates of consumption, herbivory is expected to have a very minor impact on Big Pine partridge pea and is not a concern.

D. The inadequacy of existing regulatory mechanisms:

The Florida Department of Agriculture and Consumer Services designated *Cassia keyensis* (= *Chamaecrista lineata var. keyensis*) as endangered under Chapter 5B-40, Florida Administrative Code. This listing regulates take without permission of the landowner. It provides little or no habitat protection beyond the States Development of Regional Impact process, which discloses impacts from projects, but does not provide regulatory protection for plants on private lands.

Monroe County requires mitigation for impacts to rare plant species. If Big Pine partridge pea is found on a property that is to be developed, the property owner would be required to pay a mitigation fee to the County prior to development. This process allows for the loss of individual plants and habitat and does not fully protect the species or its habitat.

The small population on Cudjoe Key resides strictly along a roadside. Accordingly, it is likely vulnerable to disturbances including road maintenance and potentially illegal dumping. There are no or limited protections for this vulnerable population. Although the potential impact of inadequate regulatory mechanisms for the Cudjoe Key population is high, this threat is relatively low on Big Pine Key, due to land ownership patterns and the Big Pine and No Name Keys HCP. However, the Incidental Take Permit for the HCP will expire in 2014. Overall, at present, this threat is considered low since the majority of the population is on protected lands or lands addressed in the HCP.

E. Other natural or manmade factors affecting its continued existence:

Application of pesticides to control mosquitoes may be impacting populations of Big Pine partridge pea by limiting pollinator populations. The flowering season of the species overlaps with the peak of mosquito activity and pesticide application to control mosquitoes in June and July (Liu 2003, p. 7). Liu (2003, p. 14) found declines in the population of one genus of pollinator after spraying events. There were no declines with the second known pollinator genus (Liu 2003, p. 14). Reduced pollinator visits likely accounted for lower fruit production (Liu 2003, pp. 16-17). The pesticide application on Big Pine Key will continue to impact pollinator populations and thus the population of Big Pine partridge pea. At present, even with reduced pollinator populations, the species still has a strong reproductive output (Liu *et al*. 2005a, pp. 205-216). Liu and Koptur (2003, p. 1186) recommended limiting pesticide applications to control mosquitoes to no more than weekly. However, at this time, the likelihood of implementing this reduction is unlikely.

Exotic plants have significantly affected pine rocklands. At least 277 taxa of exotic plants are now known from pine rocklands in south Florida (Service 1999, p. 3-175). Bradley (2006, pp. 25-26) found that 12.1 percent of pine rockland plots on Big Pine Key had exotic plants, and that Big Pine partridge pea had a significant negative correlation with exotic species richness in sample plots. The most frequent exotic plant species recorded were *Schinus terebinthifolius* (Brazilian pepper), *Fimbristylis cymosa* (hurricane sedge), *Swietenia mahagoni* (West Indian mahogany), and *Stenotaphrum secundatum* (St. Augustine grass). Some of these may compete directly with Big Pine partridge pea for space and resources, while others have a profound effect on community structure and responses to fire. Brazilian pepper is the most widespread and one of the most invasive species. If left uncontrolled in a fire-suppressed pineland, it will form a dense monospecific canopy almost completely eliminating native vegetation. It will also affect the characteristics of a fire when one does occur. Fires that once burned fairly coolly with mostly pine needle duff for fuel may now burn much hotter and affect the vegetation that develops following fire. For instance, under some post-fire circumstances, *Pteridium aquilinum var. caudatum* (dense bracken fern) thickets develop (Ross and

Ruiz 1996, p. 4). Therefore, in the presence of exotic species, additional factors must be accounted for in order to manage fire for the benefit of Big Pine partridge pea. At present, Brazilian pepper is largely under control in intact pine rockland on NKDR lands and the Terrestris Preserve.

In a recent study to better understand the location and extent of invasive exotic plants and rare native plants along roadways in Miami-Dade and Monroe Counties, 88 of 121 (73 percent) total target exotic plant species were found in at least one road segment (Gorden *et al*. 2007, p. 10). Of the 16,412 road segments surveyed, 6,264 (38 percent) contained at least one exotic plant species; some segments contained more than one species of invasive exotic plant (and as many as 15) (Gordon *et al*. 2007, pp. 10-11). In Monroe County, the most frequent invasive exotic plants recorded were Brazilian-pepper, *Leucaena leucocephala* (white leadtree), and punctureweed (Gordon *et al*. 2007, p. 11).

Hurricanes and tropical storms are an additional threat, particularly to the extent that they yield storm surges with salt-water overwash. Hurricane storm surges can inundate landscapes with saltwater for varying durations. Klimstra (1986, p. 3) stated, The effects of salt water on pinelands is well established as a consequence of hurricane Betsy, September 8, 1965. After 20 years the site where waters were entrapped for several hours has not yet fully recovered from complete loss of Pinus, Ernodea, Randia, Pisonia, and Metopium seedlings. The small area of occupancy and somewhat patchy distribution of Big Pine partridge pea renders it susceptible to extinction through such stochastic events. Hurricane Wilma in 2005 resulted in substantial reductions in population size and distribution. The surge reduced the population by as much as 95 percent in some areas (Bradley 2006, p. 13). The long term impacts of this hurricane are uncertain. However, slash pine needle-fall (litter) appears to provide for fire advancement in pine rockland communities. Because large areas of slash pine are dead since Hurricane Wilma, and may remain so, fire may no longer occur and provide important functions that enable the persistence of Big Pine partridge pea and other flora in these communities.

Hurricane Wilma negatively impacted both species richness and diversity of pine rockland flora, with significant declines in both northern and southern Big Pine Key (Bradley and Saha 2009, p. 15). The storm surge associated with Hurricane Wilma had a direct negative impact on Big Pine partridge pea, as well as *Chamaesyce deltoidea* (wedge spurge) and herbaceous species density and cover in general (Bradley and Saha 2009, p. 27). The increasing vulnerability of the Keys due to storm surge may be as important as loss of habitat resulting from sea level rise (D. Martin, botanist, pers. comm. 2011). The percent cover of graminoids, herbaceous species, and slash pine declined significantly after Hurricane Wilma (Bradley and Saha 2009, p. 15). In contrast, the percent cover of palms and hardwoods, particularly thatch palm and *Conocarpus erectus* (buttonwood) increased significantly between 2005 and 2007 (Bradley and Saha 2009, p. 15). Accordingly, hurricanes do not hinder the successional advances seen in the absence of fires and may exacerbate them. Plots that had burned more recently showed a greater recovery of both Big Pine partridge pea and wedge spurge populations. Bradley and Saha (2009, p. 26) found that candidate plants in pine rockland were restricted to sites in which ground elevation was greater than 0.5 m (1.6 feet). Both Big Pine partridge pea and wedge spurge densities were significantly, positively correlated with elevation (Bradley and Saha 2009, p. 26). Bradley and Saha (2009, p. 30) concluded that, increased hurricane frequency may have a devastating impact on candidate plant taxa and on species composition in pine rocklands of the lower Florida Keys. Researchers are proposing to conduct studies on variation of salt tolerance in Keys legumes, including Big Pine partridge pea, by characterizing genes expressed in plants and their associated microbes (E. Bishop-von Wettberg, Florida International University, pers. comm. 2010).

Bradley and Saha (2009, p. 22) examined hurricane effects in relation to time since fire to assess whether differing fire regimes influence hurricane resilience or post-hurricane recovery. Bradley and Saha (2009, p. 23) detected a significant positive effect of recent fires on species richness, suggesting that a, recently burned area is more likely to recover from the hurricane and resemble pre-hurricane species composition than an area long unburned. Similarly, Big Pine partridge pea density in recently burned plots was significantly higher than in long unburned plots. Accordingly, after the hurricane, both Big Pine partridge pea recruitment and species richness in general were found to be influenced by time since fire, with more recently burned plots benefiting (Bradley and Saha 2009, p. 23). Bradley and Saha (2009, p. 29) found that the impact of time since fire, on hurricane recovery was clearly significant for Chamaesyce deltoidea which exhibited greater rate of recovery in recently burned plots. They suggested that the colonization of plots by Big Pine partridge pea may be attributable to recent fires that provided for habitat suitability through hardwood removal. Bradley and Saha (2009, p. 29) concluded that fire provides for, optimal levels of canopy cover thereby allowing successful recruitment of candidate and rare species, that, fire may be an important tool in shaping the hurricane effects on candidate taxa and vegetation structure of pine rockland habitat, and that a fire regime, should be maintained in the wake of hurricanes which eliminate the populations of candidate taxa.

In summary, pesticide application to control mosquitoes is a threat to the Big Pine partridge pea through limitation of its pollinator populations. Exotic plants are a threat, which is reduced through active management. Tropical storms and hurricanes are continuing threats. The Big Pine partridge peas small area of occupancy and patchy distribution place it at risk to stochastic events. Overall, we find the magnitude of these threats to be moderate.

1. West Indian mahogany is native to a limited area of Florida. Its natural range does not include Big Pine Key, where it has been introduced for landscaping and has since escaped into pine rocklands

Conservation Measures Planned or Implemented :

Most of the remaining population on Big Pine Key is protected from development due to its presence on conservation lands owned by the NKDR, the State, County, or TNC. An HCP has been completed for listed species on Big Pine and No Name Keys (Monroe County *et al*. 2006, pp. 1-8). This plan benefits Big Pine partridge pea because of its provisions for habitat protection. This plan limits development mainly to previously cleared lands within a significant portion of the Big Pine partridge peas current range on Big Pine Key. Under the provisions of the HCP, no more than 168 acres (68 ha) will be allowed to be developed over the next 3 years, and of this no more than 7 acres (2.8 ha) will be native habitat.

The Services Coastal program provided $100,000 for a two-year project that will help restore pine rocklands in the Keys (D. DeVore, pers. comm. 2010). The Partners for Fish and Wildlife program is also supporting similar habitat restoration projects in the Keys.

The FDOT collaborated on and funded a study of the approximately 650 miles [1,046 kilometers] of FDOT roadway in Miami-Dade and Monroe counties (District 6) (Gordon *et al*. 2007, pp. 1, 3). The study was conducted by The University of Florida, in collaboration with IRC and the FNAI to survey and map exotic and rare native plants along FDOT right-of-ways within Miami-Dade and Monroe counties and to create a database that can be updated to reflect future activities and conditions (Gordon *et al*. 2007, pp. 1, 3).

Fairchild Tropical Botanic Garden developed a Conservation Action Plan for this taxon (Muir and Liu 2003, pp. 1-7). The plan recommended prescribed fires, fire analogues (e.g., selective vegetation thinning), limited pesticide application to control mosquitoes, outplanting, and removal of exotic plant species. Subsequent field studies (Liu 2003 pp. 1-190; Liu and Koptur 2003, pp. 1180-1187; Liu *et al*. 2005a, pp. 210-221; Liu *et al*. 2005b, pp. 71-76) included additional aspects of Big Pine partridge pea ecology including fire ecology and demography (discussed above), breeding systems, and pollination. These papers provide extremely useful guidance in the management of Big Pine partridge pea, particularly in regards to the timing and frequency of fires (see Habitat/Life History above), and also recommend limiting pesticide applications to control mosquitoes (Liu and Koptur 2003, p. 1186).

Summary of Threats :

Big Pine partridge pea is rare because of long-term human influences. It has been eliminated from several islands where it once occurred because of development and fire suppression, and now occurs on two islands. Climatic changes, including sea level rise, are serious long-term threats that will continue; these factors are expected to continue to impact pine rocklands and ultimately, substantially reduce the extent of available habitat, especially in the Keys. Models indicate that even under the best of circumstances, a significant proportion of upland habitat will be lost on Big Pine Key by 2100 (Clough 2008, p. 23). This will severely impact the viability of the Big Pine partridge pea, probably limiting it to the highest elevations in small portions of Big Pine Key, and completely eliminating suitable habitat on all other islands in its historic range. This species is threatened by fire suppression, pesticide applications to control mosquitoes, exotic plants, and sea level rise. Because of the small geographic range of the taxon, it is susceptible to stochastic events like hurricanes and tropical storms, particularly as a result of storm surge. This is evident from the tidal surge generated by Hurricane Wilma in 2005 that flooded much of the habitat for Big Pine partridge pea. The surge reduced the population by as much as 95 percent in some areas (Bradley 2006, p. 13). Pesticide applications to control mosquitoes occur most commonly during the peak summer flowering period of the taxon (Liu 2003, p. 18). Pollinator populations have been reduced because of this, which is limiting reproductive success (Liu 2003, p. 18). This will continue to be a threat to the taxon unless changes are made in mosquito management strategies. Where exotic plants occur in pine rocklands, population densities of Big Pine partridge pea are reduced (Bradley 2006, pp. 25-26). This is most evident in the more fragmented, difficult to manage parcels in southern Big Pine Key wherein private parcels and disturbed areas are extensively interspersed. In contrast, on the larger conservation parcels in northern Big Pine Key, more substantial populations of partridge pea are more consistently protected from this threat through ongoing vigilance and control of exotics. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

For species that are being removed from candidate status:

_____ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

Recommended Conservation Measures :

The largest benefits to this taxon would be accomplished with an increase in prescribed fires and by limiting pesticide applications to control mosquitoes. Prescribed fires should be conducted across all pine rockland areas in NKDR and other portions of Big Pine Key, Cudjoe Key, and on islands which formerly had populations of this taxon. Southern areas of Big Pine are particularly fire suppressed, and would probably benefit from mechanical understory removal treatments prior to prescribed fires. As recommended by Liu et al. (2005a, p. 219) and Muir and Liu (2003, p. 5), fires should occur at different times of the year (both wet and dry season) at a frequency of about 7 years. NKDR has incorporated these recommendations into its Comprehensive Conservation Plan, which calls for a revised Fire Management Plan. Those plans should be completed and executed as soon as feasible. The Service should continue to work with the Florida Keys Mosquito Control District to assess and reduce the use of truck-delivered adulticides (permethrins) from roadsides with NKDR lands adjacent.

Muir and Liu (2003, p. 5) recommend fire analogues as a management tool. Techniques such as limb cutting or selective thinning to open the pine rockland canopy are suggested. These techniques will most likely be the most beneficial in pine rockland areas that have undergone long periods of fire suppression. There are many such areas in the southern half of Big Pine Key. Mechanical treatments may be effective in preparing for prescribed fires.

As discussed by Liu and Koptur (2003, p. 1186), pesticide applications to control mosquitoes should be limited to about once a week (a reduction from about every other day) to allow pollinator populations time to recover between application events. Muir and Liu (2003, p. 5) also recommended against daily applications of pesticides.

The Service and other agencies should continue exotic plant control programs in pine rockland habitat. Exotic plant densities in most pine rockland areas on Big Pine Key are currently low, and management should continue to prevent spread of aggressive exotics.

Big Pine partridge pea should be outplanted to islands where it formerly occurred (Muir and Liu 2003, p. 6). Bradley and Saha (2009, p. 4) surveyed No Name and Little Pine Keys in 2007 and 2008. However, Big Pine partridge pea was found to remain extirpated. If it is not found on those islands, outplantings should occur in open understory areas on both islands, which are part of the species historic range.
Engage stakeholders to protect the small population on Cudjoe Key that resides strictly along a roadside. Notify Monroe County road maintenance and law enforcement personnel about the location and specific problems that need to be prevented.

Priority Table

<table>
<tr><td>Magnitude</td><td>Immediacy</td><td>Taxonomy</td><td>Priority</td></tr>
<tr><td rowspan="6">High</td><td rowspan="3">Imminent</td><td>Monotypic genus</td><td>1</td></tr>
<tr><td>Species</td><td>2</td></tr>
<tr><td>Subspecies/Population</td><td>3</td></tr>
<tr><td rowspan="3">Non-imminent</td><td>Monotypic genus</td><td>4</td></tr>
<tr><td>Species</td><td>5</td></tr>
<tr><td>Subspecies/Population</td><td>6</td></tr>
<tr><td rowspan="6">Moderate to Low</td><td rowspan="3">Imminent</td><td>Monotypic genus</td><td>7</td></tr>
<tr><td>Species</td><td>8</td></tr>
<tr><td>Subspecies/Population</td><td>9</td></tr>
<tr><td rowspan="3">Non-Imminent</td><td>Monotype genus</td><td>10</td></tr>
<tr><td>Species</td><td>11</td></tr>
<tr><td>Subspecies/Population</td><td>12</td></tr>
</table>

Rationale for Change in Listing Priority Number:

Magnitude:

Big Pine partridge pea primarily exists as a single large population on Big Pine Key with a small subpopulation on Cudjoe Key. This narrow range makes it particularly susceptible to several threats. Population size was reduced sharply following Hurricane Wilma. Reduced pollinator activity and suppression of pollinator populations from pesticides used in mosquito control and decreased seed production due to increased seed predation in a fragmented landscape may also affect Big Pine partridge pea; however, not enough information is known on this species reproductive biology or life history to assess these potential threats. The effects of forest fragmentation may also be a problem. At this time, we believe that a very narrow distribution, combined with fire suppression and hurricane and sea-level rise interactions, results in a moderate threat magnitude. However, over the long-term, sea level rise is expected to become a major threat to the taxon and its habitat; this threat will be difficult to address.

Imminence :

Land acquisition for NKDR is largely completed, so immediacy of threats are primarily questions of the rate of sea-level rise and frequency of saltwater storm surges, adequacy and effectiveness of prescribed fire in the pinelands, severity of impacts from pesticide application to control mosquitoes, and spread of exotic plants. Sea level rise is a long-term historical, current, and future threat that is resulting in the loss of pine rocklands. Some fire management is being accomplished, but at a much slower rate than is required, and only in portions of the range of Big Pine partridge pea. Pesticide application to control mosquitoes has been documented to locally reduce reproductive output of Big Pine partridge pea by limiting pollinator populations. Exotic plants have been largely controlled on NKDR lands that harbor Big Pine partridge pea, and this threat is non-imminent at present. Hurricane Wilma impacted populations on all but the highest elevations on Big Pine Key, indicating that imminence is high given that hurricanes (and storm surges) of various magnitudes are recurrent events in the area. Although the majority of threats are non-imminent, the most consequential threats (hurricanes, storm surges) are frequent, recurrent, and imminent.

__Yes__ Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

Emergency Listing Review

__No__ Is Emergency Listing Warranted?

There was an accelerated population decline followed Hurricane Wilma in 2005. However, the total population remains substantial, but restricted to two islands.

Description of Monitoring:

The Service has conducted extensive literature searches and obtained all recent and most historical documents pertaining to Big Pine partridge pea. Data on historical locations have been obtained by compiling herbarium specimens from herbaria in Florida (Fairchild Tropical Botanic Garden, Florida State University, University of South Florida) and the New York Botanical Garden.

The majority of known populations of Big Pine partridge pea occur on Big Pine Key, and most of those are within NKDR. Ross and Ruiz (1996, p. 5) found Big Pine partridge pea to be well distributed on NKDR, where they found it among 130 of 145 (89 percent) of their pine rockland sample plots. Big Pine partridge pea is not regularly monitored on NKDR. To fill this gap, the Service funded a project (Bradley 2006, pp. 1-41; Bradley and Saha 2009, pp. 1-31) to comprehensively assess Big Pine partridge pea abundance on NKDR and other conservation lands in pine rocklands throughout the Lower Keys. The survey framework derived from this study will allow for monitoring of trends and threats over time, if funding are provided periodically.

The Service is collaborating with TNC and the IRC to assemble, reconstruct, and render on GIS all known wildland fire histories for the lower Keys, including the prescribed fires on and adjacent to NKDR in recent years (Bradley and Saha 2009, pp. 1-31). We are attempting to ensure that the fire history distribution is appropriately incorporated into the sampling scheme of future inventories and monitoring efforts, so that further inferences may be drawn as to the effects of varied fire regimes and other factors, including storm surges.

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

none

Indicate which State(s) did not provide any information or comment:

Florida

State Coordination:

The Service requested new information (observations, data, reports) regarding the status of this plant or any new information regarding threats to this species and its habitat from: Florida Department of Agriculture and Consumer Services, National Park Service, Service (National Wildlife Refuges), Florida Department of Environmental Protection, Miami-Dade County, Florida Fish and Wildlife Commission, FNAI, IRC, Historic Bok Sanctuary, The Nature Conservancy, FTBG, Archbold Biological Station, NatureServe, University of Central Florida, Florida International University, University of Florida, Princeton, members of the Rare Plant Task Force, botanists, and others. In total, a previous version of this assessment was sent to approximately 200 individuals. Few comments were received.

No new data or comments were received from the State for this assessment. Information and data previously provided have been incorporated into this assessment.

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Approval/Concurrence:

Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: 07/15/2013
Date

Concur: 10/28/2013
Date

Did not concur: ______________________ ______________
Date

Director's Remarks: